ONR LONDON CONFERENCE REPORT

C-6-72

OFFICE OF NAVAL RESEARCH

BRANCH OFFICE LONDON ENGLAND

SCIENCE, MAN AND ENVIRONMENT

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13 March 1972

UNITED STATES OF AMERICA

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Office of Naval Research Branch Office, London, England

2a. REPORT SECURITY CLASSIFICATION

2b. GROUP

3. REPORT TITLE
SCIENCE, MAN AND ENVIRONMENT

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
N. A.

5. AUTHOR(S) *(First name, middle initial, last name)*
EDWARD I. SALKOVITZ

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
13 March 1972	24	

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
N. A.	C-6-72
b. PROJECT NO. N. A.	
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)* N. A.
d.	

10. DISTRIBUTION STATEMENT
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
N. A.	N. A.

13. ABSTRACT

At the Fourth International Science and Society Conference, which was held in Herceg-Novi, Yugoslavia in July 1971, the major theme was "Science, Man and His Environment." After a series of papers which served to delineate the fields for discussion, attention was turned to problems relating economic and technical development to the environment, then the role of man within the environment. Papers followed on urban planning, control of resources, education, information and legislation.

DD FORM 1 NOV 68 1473

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Science Policy						
Environment						
Pollution						
Technology						
Ecology						
Natural Resources						

SCIENCE, MAN AND ENVIRONMENT

INTRODUCTION

Herceg-Novi in Yugoslavia is a beautiful resort town on the shores of the Adriatic Sea, which has become the site of many international conferences. It was here, during the period 3 through 10 July 1971, that I attended the Fourth International "Science and Society" Conference whose theme this year was "Science, Man and His Environment." The meeting was well attended, with 300 participants from 25 countries. Regrettably, the pre-registered Russians did not show up. Details including names of speakers and titles of their talks are included in the appendix. The organizers of the Conference worked very hard to make this one successful and enjoyable. Simultaneous translation was available with excellent interpreters. By using earphones, it was possible for one to sit out on attractive patios in front of the conference hall and listen to the proceedings, sipping his favorite beverage (ranging from expresso to slivovitz). Very pleasant diversions were also provided; a boat ride, a picnic on an island, a folk concert, a tour to the ancient city of Dubrovnik, and a science-fiction film festival.

In my brief preliminary account of the meeting (ESN 25-8; 31 August 1971), I referred to the nationalistic and jealous rivalry that exists among the six republics that make up the federation known as the Socialist Federal Republic of Yugoslavia. Many Yugoslavs with whom I talked expressed concern for the future of their country. Religious differences are strong and memory of the struggles between the Fascists and partisans have been renewed by the recent acts of terrorism perpetrated by the exiled Croatian nationalists (Utashi). President Tito's concern is reflected in his removal of several leaders from their posts in the government of Croatia. But of concern to all Yugoslavs is what happens after Tito?

Although Yugoslavia is making a strong effort to increase tourism, probably it has not been visited by most readers of this report, so I will present a few facts about the country. The Federal Socialist Republic of Yugoslavia, with a population of 21 million, consists of six constituent socialist republics: Bosnia-Herzegovina, Croatia, Macedonia, Montanegro, Slovenia and Serbia. In addition, two autonomous provinces, Vojvodina and Kosovo are part of Serbia. Kosovo borders Albania and contains many Albanians. The largest city is Belgrade with a population of about 700,000; it is the capital of Yugoslavia as well as Serbia, while Zagreb with a little more than 500,000, is the second largest city and is the capital of Croatia. More than 2/3 of the area of the country consists of mountains and highlands.

The list of ethnic groups which inhabit Yugoslavia is long indeed, but nearly 90% of the population is made up of Croats, Serbs, Slovenes, Macedonians and Montenegrins. The largest religious groups are the Roman Catholic Church (Croatian), the Orthodox Church (Serbia) and the Islamic community.

There are substantial water power, forest and mineral resources in Yugoslavia, and in the latter category, bauxite, copper, lead and zinc are of primary importance. Since 1950, there has been a vigorous rate of industrial growth, as measured by electric power, steel and several non-ferrous industries as well as the chemical industry. For those who wish to pursue the subject further, I would recommend the article "Power Development in Yugoslavia" by J. Salom Suica, Bulletin of the Atomic Scientist, p. 42, November 1971. The problem is of increasing importance, since the country has moved from an agricultural economy with a real per capita income of $130 per year in 1946 to a significantly industrialized one with a per capita income of $750 per year (although the income discrepancy between Bosnia-Herzegovina and Slovenia is a factor of 3 in favor of the latter). I was interested to learn that in this socialist country there were 2.6 million privately owned peasant holdings totaling 8.9 million hectares (1 hectare = 10,000 m^2) of a total 14.9 million hectares of farmlands, not all of which is arable.

But to return to the Conference. The format was that now familiar to Gordon Conference attendees. Morning sessions would run from 8:30 a.m. to 12:30 p.m., interrupted by a coffee break - during which an assortment of interesting beverages were available. The afternoons were free and evening sessions were scheduled to run from 5 p.m. to 7 p.m., although I can recall one or two that did not end until 9 p.m. The sessions were entitled:

I. General Considerations

II. Economic and Technological Development and Environment

III. Man as the Object and Subject of Environment

IV. Urbanization and Space Planning

V. Control of Natural Resources

VI. Protection of the Biosphere

VII. Science and Education

VIII. Information, Legislation

Among the distinguished dignitaries who delivered welcoming addresses was Dr. Augustus Lah, Chairman of the Cultural and Educational Chamber of the Federal Assembly. Lah noted with pleasure the presence of a large number of deputies of the Chamber because the theme of the Conference had been placed on the agenda for the next session of the Chamber in order to explore the possibilities of legal regulation of the environment and rational utilization of resources with simultaneous preservation of the natural beauty of the country. In its rapid economic and social development, Lah believes that Yugoslavia must discontinue the practice of making decisions concerning the construction of different projects solely on the basis of financial considerations. Lah was impressed with the variety of professions and disciplines represented at the Conference in view of the interdependence "between economic development, structural changes in society, and men's activity in the transformation of nature."

After Lah's talk approximately 80 papers were delivered. Obviously, I will review only a fraction of these. The first was that by Professor P. H. Chombert de Lauwe, Paris, and was on "Science, Culture and Environment." De Lauwe began by posing the question of why the subject of man's environment has been raised so much in the last few years. Are we the victims of two illusions, he asked: A false threat and a false hope? A false threat because we should not fear the environment, but rather the people who make it. A false hope because it may be naive to believe that a technological transformation of the environment will enable society to be changed. He argued that society itself should first be changed. All societies, capitalist and socialist, encounter the same difficulties, but the ways in which they resolve these problems may be different or even contradictory. De Lauwe then distinguished between environment and social surroundings. In his framework, environment is the body of physical elements of the surroundings in which a given people live. These elements, of course, can be modified by the people themselves through their work and actions. The expression "social surroundings," however, he said, is applied to the group of people observed from within that group. Thus, distinguishing between environment and social surroundings, de Lauwe posed three problems: dynamics of the environment, creation of the environment, and the interaction between culture and environment. Air, water, light, vegetation, animals, are all exploited for human welfare, while simultaneously people interactions are reflected in the environment. These are the kinds of ideas that are involved in the concept of the dynamics of the environment. These thoughts then lead to the problem of creating the environment which de Lauwe said was more than just a technical problem. He returned to the argument that if the environment is a creation of society, then a study should first be made of society - its economy and structure, the psychology of people comprising it, their ideas, their needs, conflicts

and aspirations. And this, of course, leads to the third area mentioned above; namely, culture and the environment. He concluded his talk with the statement that the optimal interaction between man and the environment is the one which, while increasing man's control over his natural environment, creates conditions for the maximum possible self-realization of man. In the course of his talk de Lauwe had stated that socialist countries had been more successful in dealing with problems of the environment. Professor S. W. Dedjir, Sweden, in the discussion which followed remarked that the Marxist countries had, in fact, awakened to the problems rather later than the capitalist world and were embarrassed by their lack of progress, possibly because Karl Marx had ignored questions of environment and pollution.

In a sense Professor Paul Meadows', State University of New York, Albany, paper, "The Contemporary Rediscovery of the Environment," was a companion to the earlier paper of de Lauwe. The contemporary concern with the stabilization and preservation of the environment is a revolutionary shift from the ancient habit of thinking separately of man and the environment. One is concerned now, he said, with a new environment synthesis in which the drama of the changing earth is one wherein man is an integral part of the action. To aid and abet this new environmental synthesis, much is needed: (1) an extensive understanding and support of the ecological approach, (2) a change from a purely technological, to a bio-technological orientation, (3) a philosophical reorientation from the environment as something static to the environment as a process, (4) finally, a desirable balance must be found between the limits and possibilities of "finitism" and "infinitism." Meadows elaborated considerably on this point. Nineteenth century European social thought formulated contrasting guide lines for growth. On the one hand Jacobinism asserted the infinite expansion of technology and institutions in the amelioration of the human condition. On the other hand, Malthusianism pounded away at the limitations of technological social action, stressing the recurring shrinkages in human numbers under the pressure of inevitable biological destruction and resource disruptions. Thus Malthusian ratios of finite resources and equilibrating natural processes were pitted against the Jacobin ratios of infinite technological social expansion. In a sense the Malthusians could be considered the pessimists and the Jacobins the optimists, and very little in the nineteenth and early twentieth centuries (especially in view of the rapid growth in the industrial west) contradicted Jacobin optimism. The underlying problem of the current environmental crisis concerns therefore the rate and style of growth. There is the ecological imperative to preserve and to enhance the dynamic equilibria of the ecological systems of the earth. But there is also the techno-social imperative to continue the historical pattern of expansion in the interest of the quality of life. The focal question with which Meadows concluded was can we find a synthesis of these opposing views?

As though in answer was the paper by Dr. Fritz Lienemann, Staff Director, Berlin Center for Future Research, on "Outline of a Comprehensive Environment Protection Policy." He first emphasized that because his remarks were directed at long-range, future-oriented policies, they might not be applicable to the present acute crisis situation, and then proceeded to enumerate factors which contributed to the complexity of the problem. For example, it is sometimes barely possible to identify the elements which are directly responsible for pollution. Thus, dangerous effects may arise from a combination of several chemical substances in the atmosphere which taken individually are harmless. It is also difficult to establish "norms" or "datum lines." What is the absolute medical definition of "healthy?" What is the "normal" situation of the environment? Because of nebulous answers to these questions, Lienemann asserted that all environmental problems are subject to value judgments and therefore all members of society should be involved in the "valuing" process. In Germany it has been suggested in official circles that by 1985 no citizen of that country should be more than 15 km from an autobahn. But do all German citizens want their country to be covered by a dense net of asphalt strips? Perhaps a positive result of some environmental dangers was that the societal relevance of technology and of the economy was for the first time brought home to a broad public. Lienemann next declared that he thought the creation of a "Ministry for the Environment" was unrealistic. The relation of environmental problems to agriculture, transportation, conservation, etc., precludes a single environment policy because a single policy would neglect the diversity of these major areas of human endeavor. Instead, he suggested powerful environment offices be established in various appropriate government agencies and then turned to consequences of a long-range environmental policy particularly with Germany in mind, dealing with four aspects:

a. Consequences for society. To help determine what these might be, it is necessary to establish a public forum for environmental questions. As a trial, a successful television "phone-in" took place on this subject in February, 1971. More positive action, however, must be taken by the citizens. As new status symbols, are they prepared to replace the motor car with products which are kinder to the environment?

b. Consequences for the economy. This task is to put into proper relation, on the one hand, the environmental effects accompanying a certain rate of economic growth, and on the other hand, to put limits to the economic costs of environment protection. Lienemann believes that the social costs of endangering the environment must be assumed by the "guilty." Governments can burden with fees and taxes production processes dangerous to the environment. The problem is to determine the capacity of the economy to protect the environment.

c. Consequences for Research and Development. A long-range policy will surely lead to interdisciplinary research, engaging teams of a variety of physical and social scientists and engineers in the development of "clean" technologies.

Whereas Lienemann looked upon the problem from essentially a national viewpoint, in a later paper W. S. Cole. W. W. Grigorieff and E. R. Trapnell examined "The Environment and International Action." Of the three authors, the first has had a career primarily political (W. Sterling Cole was the founding Director General of the International Atomic Energy Agency), the second is an Oak Ridge scientist experienced in administration of technical programs, and the third, now at NSF, has had experience in governmental and industrial public relations dealing with resources and environmental problems. So here we had one kind of interdisciplinary team asked for by Lienemann. Trapnell, who gave the talk, examined the role that multinational agencies should play in the control of the quality of man's physical environment. The first requirement for defense against assault on the environment is education. The multinational agencies can take as a major assignment spreading the lesson around the world, that man's resources and environment are finite and that demands upon them must not continue to increase at an exponential rate. For example, the per capita consumption of water rises yearly, but the total amount of water in the earth's biosphere probably has not changed since the time Noah gave pause to consider it. We do not know where the danger lines are, in terms of total utilization, either for the water which we collect and store and then redistribute for agricultural, industrial and domestic use, or for the air which previous generations assumed had an infinite capacity to waft away undesirable gaseous or particulate impurities. One role for the agencies would be to determine where these danger lines are, how close we are to them and to determine what has already been done to the environment. In summary then, if multinational agencies were to take on the assignment, the first phase would involve data gathering and analysis, whereas the second phase would involve the setting of standards.

Still in this series of papers was one by Ing. M. Tepina, Director, Institute for Town Planning of Slovenia, Yugoslavia. Tepina has had a very interesting career. At one time he studied with Le Corbusier in Paris; betwen 1957 and 1961, he served as Director of the Federal Institute for Urban Development and Housing; and then was elected mayor of Ljubljana and at the same time was Chairman of the Faculty of Engineering Council at Ljubljana University. He was also the Yugoslav representative on the OECD Committee on Environment. The paper he presented bore the lengthy title, "International Implications of Degradation and the Policy of Protection of the Human Environment." Noting the millennia which were required for the various stages for biological development of man, he

indicated that only nine decades were needed to go from steam machines to atomic power stations, from telephone to television communication with the moon and also from grenades to interplanetary rockets. During this technological growth, the development of social relations has lagged far behind. Unfortunately, just as it did thousands of years ago, mankind still frequently resorts to force in order to resolve internal conflicts. As his predecessors, Tepina emphasized that, in the not-too-distant past, man assumed that the natural elements--land, water and air--were inexhaustible, but these now, of course, are in jeopardy with respect to quantity as well as quality; and therefore, a policy of protection of the environment as an independent social discipline, must be nurtured and developed. He went on to say that all forms of environmental degradation and protection policy have international implications and are of special significance in the fields of international politics, economic development, trade, law and scientific and cultural cooperation. This has been recognized by the majority of governments of the developed countries. But, he said, constraints of economic growth, especially in underdeveloped countries, could be more harmful to the conditions and interests of human happiness than would be environmental degradation. He felt a new kind of technology could be discovered, however, which would neither restrain economic development nor imperil the qualities of the human environment. In a policy of environmental protection, it will be necessary to apply a number of restrictive measures which, however, will not have a negative effect on the growth of production. Restrictions on the optimum locations for power plants, the limitation of the use of natural resources, restrictions on the elimination of wastes all have a direct influence on investment profitability and production processes, as well as on the placement of the product in domestic and foreign markets. Underdeveloped countries can apply, hopefully, preventive methods, using the experience of the highly developed countries. The agencies entrusted with assistance to underdeveloped countries should regard this consideration as part of their international obligation.

Tepina then noted that many underdeveloped countries, such as Yugoslavia, have looked to tourism as an essential element of their national economy and are faced with the problem of sacrificing their cultural inheritance and unspoiled natural beauty for the sake of industrial development. He considered this point in some detail and concluded very much as Meadows had, stating that the final question was whether politics, science and culture and mankind as a whole can succeed in making its contribution to a new quality of life.

Another paper in this first session was entitled "Improving the Environment through Hard-Soft Science Innovations." It was given by Mrs. F. L. Groomes, Associate Director of Project Upward Bound, Florida A&M University, Tallahassee, Florida. First she directed attention to the

anomalies ("insanities" she called them) that exist in today's society. These included economic imbalances, unemployment, pollution, and bigotry. With tongue in cheek noting that she is a black female social scientist, she proposed "an engagement between the hard (physical) and soft (social) scientist with contemplation of marriage in the near future." Turning to the plight of Black institutions of higher learning in the US which she characterized to be inadequately supported financially and lacking significant relationships with key decision makers, she found they did not function to the maximum potential in regard to the population they served. She then described a plan formulated by Dr. W. W. Grigorieff (Oak Ridge Associated Universities) and his colleagues which brought together teachers and administration from about 75% of the traditionally Black institutions as well as representatives from a variety of state and national agencies for a series of workshops. In her words, "Knowledge was expanded, horizons extended in reference to the scientific world, but better still, human interpersonal relations were enhanced; those who were scientific experts learned and became more aware of the needs of others, a setting was provided that allowed individuals with common concerns to collide in some instances, but also to hear varying viewpoints and approaches." Groomes proceeded to describe the operation of Project Upward Bound at Florida A&M as developed by a staff comprising both hard and soft scientists. She stated that at Florida A&M 78% of the students who finish the pre-college Upward Bound program and enter college, finish on time and a significant number go on to graduate and professional schools. Florida A&M has also a non-degree program designed to convert unskilled and unemployed manpower into skilled and employed. The talk was concluded with a recommendation for the formation of an International "Hard-Soft" Science Committee whose fundamental role would be to study and suggest methods of improving the environment on an international level. To my knowledge, no action was taken on this suggestion, although it received favorable comment in the discussion which followed.

There were other papers of this type and considerable discussion, but in the second session, devoted to economical and technological development and the environment, Prof. E. G. Mesthene, USA, asked, "Is Technology Responsible for our Social Ills?" The popular negative views of technology are of five kinds, and each of these he examined in some detail: (1) Machines deprive people of work. No - Technology eliminates jobs, not work. Certain skills become obsolete and people have to be retrained. If this problem has been poorly handled, it is society's failure, not technology's. (2) Technology robs people of privacy. The charge is levelled most frequently at wire tapping and other surveillance devices, and computerized data banks, but usually not against the telephone or commercial television. Clearly, the latter two do not deprive us of choice, but are greatly abused. By contrast surveillance devices and

data banks are beyond the control of the individual. But the problem is complex. A surveillance system to check on moral behavior (an increasingly nebulous concept) is invasion - but such a system to prevent a major crime, such as hijacking the next airplane I ride, is less objectionable. A data bank that forever reveals a silly, thoughtless prank of a teenager and thus prevents his normal development as a useful citizen, is unwarranted invasion of privacy. A data bank that displays instantly the medical history of a critically ill individual is of tremendous value. In essence, legal and technical safeguards are presently available to prevent misuse; society must take the initiative. (3) Technology is autonomous and uncontrollable by man. The supporters of this charge point to the proliferation of dreadful weapons, pollution, overcrowded cities, tensions, etc. But perhaps without technology, our own population might be living in circumstances such as presently found in India, or at best Dickens' England. Again, Mesthene argued the technology is available to prevent its own exploitation, but the fault lies with the decision makers and their procedures. (4) Technology dehumanizes. This statement contradicts history. Witness the lot of the working man in the days of Marx and Dickens. (5) Technology leads to a bureaucratic state. This is the most complex of the charges and contains much truth. The effects of technology are large, affect large segments of society. The decision-making units get larger. Government dependence on knowledge and expertise leads to negative reactions of those who demand more participation in decision-making as well as to the uncertainty of governments (and universities) who make decisions. On the one hand, technology helps strengthen the authority and power of the government; and on the other strengthens the position of the protesters. Mesthene concluded by saying that he did not mean that technology does not carry dangers and create problems. But understanding and coping with technology is not helped by mixing up real problems with imagined or invented problems, and then blaming all of them on technology.

Dr. R. M. Salter, Jr., Rand Corporation, took an optimistic view in his paper, "Application of Modern Technology in the Improvement of Man's Environment." His initial statement was that application of modern scientific methods can be made to determine effects of man on his environment. For example, high-capacity computers are now employed to model the atmosphere and to solve flow problems in estuaries. Perturbations to the flow patterns due to thermal and chemical additions are studied for optimal siting of power plants or factories. He described how advanced computer technology also permits rapid collection of data from many sensor points, emphasizing that the electronics for the sensing function can be quite inexpensive. Some of the examples he cited included measuring of thickness of snow packs, extent of crop life, and general effects of man-made sprays and fertilizers. He described how new techniques for tunnelling offer dramatic changes in transportation patterns and distribution of utilities. He turned also to the waste disposal

problem, emphasizing the need for ingenuity to achieve significant accomplishment, but on the other hand showing a few possible directions.

J. G. Parr (Windsor) echoing the previous two speakers' defense of technology, spoke on "Technology and Survival." The spread of the Roman Empire, the development of the feudal system, the flowering of the Renaissance, the beginning of the Industrial Revolution were all founded upon technological skills. Yet, today there is a universal ignorance of technology, both in developed and underdeveloped countries, and based upon ignorance there is a growing resentment of technology. But, Parr argued, technology is intimately linked with survival. He referred to H. G. Wells' concept of the "competent receiver," behind which was the notion that until people are intellectually capable of appraising policies and innovations that are formulated and developed by any sort of power group, these policies and innovations cannot be successful. Therefore, the first move towards a more humane use of technology in society must depend upon the creation of "competent receivers."

Alvin Weinberg (Oak Ridge), in his talk "Science and Trans-Science," dealt with a topic which probably has not been brought to the attention of the layman. It is Weinberg's contention that within the sphere science-society interactions there are questions that can be phrased scientifically and can be asked of science, but which cannot be answered by science. They transcend science - and so the term "trans-science." Consider the biological effects of low-level radiation insults to the environment, in particular the genetic effects in mice due to low levels of radiation. To measure an effect at extremely low levels requires impossibly large protocols. Even if no effect is observed, it can only be said that there is a certain probability that there is no effect. One can never, with any finite experiment prove that any environmental factor is totally harmless. Other examples can be quoted of trans-science questions which center around the probability of extremely improbable events. But in addition, these kinds of questions frequently arise in the social sciences. Because of the concept of homogeneity of a class of objects, the physical sciences are capable of predicting specific events from the laws of nature and the boundary conditions. The social sciences, however, deal with classes displaying wide variability, making it enormously difficult to predict individual behavior. It may be recalled that Harvey Brooks has cited a kind of "uncertainty principle" involving feedback: for example, straw vote polls may influence the outcome of the actual election, since many people prefer to vote for the candidate they think will win. Weinberg then proposed that as society weighs the benefits of new technology against its risks, one of the methods it should use is the adversary procedure. The latter involves a rather formal, quasi-legal proceeding at which scientific and nonscientific opposing views are heard. He felt this procedure

would find increasing use, at least in the US, and therefore proceeded to discuss it in detail including some criticism that has been leveled against it, particularly that in adversary procedures, representatives of the public are usually less knowledgeable than are representatives of the applicant (say, for a license to run a nuclear reactor). He concluded his talk by saying that when scientists and engineers engage in activities that transcend science and impinge on the public, there is no choice but to welcome and encourage public debate.

Leaving "trans-science," J. L. Liverman, also of Oak Ridge, turned to the subject "Making Science Serve Man." Since the end of World War II, Oak Ridge scientists, engineers, and technologists have been concerned with various aspects of environmental, pollution and ecological problems. In recent years they recognized the need to develop tools for assessing the possible deleterious impact of the new technologies before instead of after they are introduced into society. With assistance of many federal and state agencies, the Oak Ridge group are presently collecting baseline data on the chemical, physical and biological aspects of the environment for the deciduous forest area of the Eastern United States. Using this data, computer simulation models are being developed of the physical, biological, social and economic aspects of the human environment for the 16-county area around Knoxville, Tennessee. This model will eventually be enlarged to accommodate much of the Southeastern United States. As an example of the applicability of this work, Liverman described how the model was used to select the location of a regional solid waste recycle complex in East Tennessee. In the course of his discussion, he also described a telephone-linked information system on environmental matters which contacts every school system in Tennessee. Every teacher receives a monthly newsletter concerning the environment plus information on availability of films, and active organizations. A volunteer air monitoring project involving 25,000 pupils and teachers was organized whose efforts result in a monthly air purity map of the state. (Seminars, workshops and conferences also are held.)

A. Lesaja (Zagreb), an economist, gave a paper "Long Term Planning in Changing the Environment and the Criterion of Economic Efficiency" in which he applied his analysis to an unnamed coastal area of his country. In this region personal incomes were below the average for the country, and agriculture could only support 20 percent of the population. A further study showed that local industry could not compete even domestically. All this had led to economic stagnation and the need for improved living standards. A detailed analysis, however, showed that the area could become a tourist attraction, so next an analysis was made of what is necessary to exploit an area for tourism; e.g., water, sewage,

power, transportation, available hotel beds, etc. Then came a discussion of how to plan to provide these facilities--in essence a total policy for tourism. Here was an excellent example of regional planning--but a young Yugoslavian with whom I later chatted raised a very serious question. Suppose he and other of his bright young friends don't want to be caterers or hoteliers, where are they to go, and what sort of group is left behind?

In a later session, while introducing his paper on the "Scope of Human Ecology," P. Leyhausen (Wuppertal) asked several questions centered around the central theme that if Man learned to control or manage food production and natural resources, would our ecological problems be solved? His answer was an emphatic, No! Our environment is finite. Its resources are finite. Man's power of adaptability is finite. And his tolerance of his fellow man is also finite. Therefore, in Leyhausen's estimation the primary problem is management and control of the human species, especially in terms of limitation of total populations and local population densities.

As a departure from the themes of most speakers, Derek J. de Sola Price (Yale) turned to "Some Theoretical Studies in Science of Science and Their Practical Implications." He began by considering the structures and relationships of science and technology. In considering creativity he suggested that contrary to usual belief, motivation is far more important than intelligence or talent, that psychological motivation is supreme over economic, and that the ripeness of new ideas is much more determinative of what follows than the needs of society or offers of financial returns. He then made several assertions:

(a) Nearly all normal scientific and technological advances are directly built upon previous advances, but science and technology tend to be relatively separate activities, interacting only weakly, though apparently just enough as to keep in phase.

(b) The commonest interaction is for science to be "squeezed" out of a technical advance. He demonstrated how lens-grinding led to telescopes, to astronomical observations, then to proof of Copernicus' theory, to cosmology, etc.

(c) In all countries of the world, it turns out that the measure of activity (men and money) in applied science is about twice that of basic science.

(d) In most countries the bulk of trained scientists and engineers are employed in development, production and management rather than in breaking new ground. Further, it is economic expansion that occasions

more research, rather than research producing economic growth. Industries that grow most must invest most in research. That is, investment in research goes as about the cube of the growth rate of the industry. In the second part of his talk, Price turned to the growing problems of the over developed countries. Those familiar with his writings know that for 20 years he has predicted that the exponential growth of science since the mid-seventeenth century is fated for saturation toward the end of this century. He was not prepared to compute whether the primary limiting factor would be manpower, money, information systems, etc. Price now believes this prediction has been fulfilled in the US where about five years ago we passed the point of inflection of the growth curve; the Soviet Union arrived at this point more recently. Thus, though the USA and the USSR are still the largest technical nations and their technology is still growing vigorously, their growth rate has slowed down by a factor of two relative to the rest of the world. These conclusions are based on his analyses of quantity and quality of scientific publications (and this subject, too, has been discussed in his writings). Related to these comments, he asserted that a root of the present anti-science movement is the almost universal awareness of increased difficulty to obtain a worthwhile return from the increased investment of time and energy required by science.

On perhaps a pessimistic note, Price viewed the slowly changing balance of scientific and technological power among the nations to be reflected among the individual scientific disciplines. Molecular biology is now more fashionable than physics; "Environmental studies" seems to be a catchword for the demolition of much of our traditional scientific capabilities. He strongly supported good, serious environmental studies, but asked for maintenance of our scientific values as well as the basic sciences and technologies.

In the third and last part of his lecture, Price examined the special problems caused by small effective size in scientific community, as for example, an underdeveloped country. This was an excellent review of another subject with which he has dealt previously, as well as has Ben-David and which can be found discussed in recent OECD publications. Price suggests that certain national problems usually associated with the degree of economic development may in fact be due to the effective size of the scientific community. The critical size is that found in Denmark, Austria, and Romania; namely, about 0.5% of the world effort in science. He finds 16 or 17 nations are above this limit and all others below. Incidentally, Yugoslavia is just less than half critical size, although its GNP is nearly that of Denmark. If this

limit has not changed in the last century as Price believes, then Australia, India and Italy have reached critical size only within the past decade. In this paper he touched on many other interesting and related topics which I am afraid space keeps me from recording.

During one of the discussions, details were given for the city planning of Belgrade and its environs for the year 2000 when its population is expected to rise to 2,000,000. For the study, 130 demographic maps were made, each dealing with a different parameter. Thus, there were some maps which showed temperature and humidity distributions, some featured topographical and soil information, others showed ages, religious and health variables. It was argued that only with such data could a viable plan be developed. But a colleague of the speaker challenged him. It would be disastrous to give the world another megalopolis. Industry should be decentralized and should be spread among small towns. He noted that Hungary had taken deliberate steps to limit the growth of Budapest and that Poland and Czechoslovakia were moving in this direction as well. On the other hand, he said Yugoslavia had 10,000 towns with less than 200 inhabitants--and this was too small a number. Roger Revelle then gave his opinion that the twentieth century was one of urbanization. In the coming century 80% of the population will live in cities. The advantage of the city is great. Everyone can do what he wants, there is an abundance and diversity of "ecological riches." But in a small town these are limited in number. However, Revelle would like to see the functions of the city restricted to "face-to-face" activities; e.g., banking, educational, cultural, etc.

The above represents a cross section of the more significant papers. The remaining scheduled papers and unscheduled contributions dealt usually with the topics covered above. How is individual man and the community as a whole prepared to protect his environment? How can he gain maximum benefit from his country's natural resources, yet assure future generations their share of these resources? In this regard the need for legislation at the national and international level was frequently mentioned.

One criticism which was raised by many in the audience and which the organizing committee indicated would be under consideration for the next conference, was the several evening sessions which seemed interminably long, particularly because of the inappropriateness of several of the papers. These latter were dialectical discussions on art, literature, and music. As luck would have it, there same papers were the poorest delivered and always exceeded the allotted time.

It would be misleading to end on this note, for the Conference brought together people from various nations, professions and economic systems who explored important facets of a topic which many believe is germane to our very survival. Our hosts were generous and kind and made every effort to assure us a pleasant visit to Herceg-Novi.

The proceedings of the Conference are to appear early in 1972, at a price of $10.00, and will be in English. They can be obtained by writing to:

Miodrag Milivojevic
Executive Secretary
Science and Society Conference
Organizing Committee
Beograd, P. O. Box 163, Yugoslavia

C-6-72

APPENDIX

SCIENTIFIC PROGRAM

OF THE FOURTH INTERNATIONAL CONFERENCE

"SCIENCE AND SOCIETY"

3-10 July 1971

FIRST CONFERENCE DAY

Saturday, 3 July 1971

I. GENERAL CONSIDERATIONS

11 to 12:30 p.m.

1. P. H. Chombart de Lauwe, Antony

   SOCIETY, CULTURE AND ENVIRONMENT

2. F. Lienemann, Berlin

   OUTLINE OF A COMPREHENSIVE ENVIRONMENT PROTECTION POLICY

5 to 7 p.m.

3. P. Meadows, Albany

   THE CONTEMPORARY REDISCOVERY OF THE ENVIRONMENT

4. F. L. Groomes, Tallahassee

   IMPROVING THE ENVIRONMENT THROUGH HARD - SOFT SCIENCE INNOVATIONS

5. S. Cole, W. W. Grigorieff, E. R. Trapnell, Oak Ridge

   THE ENVIRONMENT AND INTERNATIONAL ACTION

6. A. Bishop, Geneva

   SELECTED ENVIRONMENTAL ISSUES OF CRITICAL IMPORTANCE IN THE ECE REGION

7. M. Tepina, Ljubljana

   INTERNATIONAL IMPLICATIONS OF DEGRADATION AND POLICY OF PROTECTION OF THE HUMAN ENVIRONMENT

THIRD CONFERENCE DAY

Monday, 5 July 1971

II. ECONOMICAL AND TECHNOLOGICAL DEVELOPMENT AND ENVIRONMENT

8:30 to 12:30 p.m.

1. R. M. Salter, Santa Monica

   APPLICATION OF MODERN TECHNOLOGY IN THE IMPROVEMENT OF MAN'S ENVIRONMENT

2. E. Mesthene, Cambridge

   IS TECHNOLOGY RESPONSIBLE FOR OUR SOCIAL ILLS?

3. B. Commoner, St. Louis

   THE SOCIAL SIGNIFICANCE OF THE ENVIRONMENTAL CRISIS

4. E. A. Johnson, Washington

   THE RESPONSIBILITY OF THE INTERNATIONAL FRATERNITY OF SCIENTISTS FOR NEW AND BETTER APPROACHES TO ECONOMIC DEVELOPMENT

5. J. G. Parr, Windsor

   TECHNOLOGY AND SURVIVAL

6. J. Liverman, Oak Ridge

   MAKING SCIENCE SERVE MAN

7. A. Lesaja, Zagreb

   LONG-TERM PLANNING IN CHANGING THE ENVIRONMENT AND THE CRITERIUM OF ECONOMIC EFFECTIVENESS

FOURTH CONFERENCE DAY

Tuesday, 6 July 1971

III. MAN AS THE OBJECT AND SUBJECT OF ENVIRONMENT

8:30 to 12:30 p.m.

1. A. M. Weinberg, Oak Ridge

   SOCIAL RESPONSIBILITY OF MODERN TECHNOLOGISTS

2. M. Markovic, Beograd

   CRITERIA FOR THE EVALUATION OF THE INTERACTION BETWEEN MAN AND HIS ENVIRONMENT

3. P. R. Bize, Paris

   THE NEEDS OF THE INDIVIDUALS; THE NEEDS OF THE GROUPS; THE NEEDS OF NATURE. THE DIALECTICS MAN-SCIENCE-THE ENVIRONMENT

4. R. P. Banet, Brussels

   THE CONCEPT OF THE "FREE NEED" IN MODERN ECOLOGICAL EVOLUTION

5. M. J. Chombart de Lauwe, Antony

   THE CHILD AND THE CITY

6. E. Rosset, Lodz

   THE DISCRIMINATION OF OLD AGE IN THE MODERN SOCIETY

7. A. O. Zupa , Ljubljana

   STONE-AGE INDIANS OF ALTO ORINOCO: A LESSON IN ECOLOGY TO SPACE-AGE MAN

5 to 7 p.m.

8. R. C. Anderson, Upton

   A RAPPROACHEMENT BETWEEN MAN AND NATURE

9. J. Vranken, Leuven

   FUTURITY AS AN ELEMENT OF THE SOCIAL ENVIRONMENT SCIENTIFIC BRANCHES WHOSE AIM IS THE CONTROL OF THAT ELEMENT

10. D. Malic, Beograd

    ENTROPYAS AS A MEASURE OF ADAPTATION OF SYSTEM TO ENVIRONMENT

11. M. Novakovic, P. Anastasijevic, Beograd

    MAN AND ENVIRONMENT, MATHEMATICAL MODEL OF INTERACTION

12. N. D. Naplatanov, J. P. Marinov, P. G. Vekov, Sofia

    OPTIMIZATION OF INTERACTION IN THE SYSTEM MAN-MACHINE BY STUDY OF QUALITATIVE INDICATORS FOR MAN-OPERATOR

13. D. Lekovic, Beograd

    PHILOSOPHICAL ASPECTS OF THE PROBLEMS OF MODERN MAN AND HIS ENVIRONMENT

14. M. Mestrovic, Zagreb

THE ENVIRONMENT OF THE CONSCIENCE

15. Z. Vidovic, Beograd

THE ENVIRONMENT - THE SCENOGRAPHY FOR THE DRAMA OF HUMAN RELATIONS

16. D. Gostuski, Beograd

THE POSSIBILITY OF MAKING ART SOLIDARY WITH SCIENCE IN THE FORMATION OF A NEW WORLD

17. P. Palavestra, Beograd

LITERATURE AS A PART OF THE REAL WORLD

18. S. Lukic, Beograd

NEW FOLK MUSIC IN YUGOSLAVIA - A UNIQUE FORM OF MASS CULTURE

FIFTH CONFERENCE DAY

Wednesday, 7 July 1971

IV. URBANIZATION AND SPACE PLANNING

8:00 to 12:30 p.m.

1. M. P. Randet, Paris

THE BALANCE OF THE URBAN ENVIRONMENT

2. B. Winiarski, Wroclaw

SOCIAL AND BIOLOGICAL PREMISES OF SPACE PLANNING

3. M. Penouil, Bordeaux

URBANIZATION AND THE ECONOMIC AND SOCIAL TRANSFORMATION; AN ATTEMPT TO MAKE A PARALLEL DIAGNOSIS - BORDEAUX - ABIDJAN

4. V. Music, Ljubljana

PHYSICAL PLANNING AS A MEANS FOR THE PROTECTION AND DEVELOPMENT OF MAN'S ENVIRONMENT

5. B. Petrovic, Zagreb

THE RELATIONSHIP BETWEEN MAN'S ENVIRONMENT AND SPACE PLANNING

6. V. Richter, Zagreb

   MAN AND HIS URBAN ENVIRONMENT - FORECASTS AND PROPOSALS

7. M. R. Ferrer, A. L. Presado, Pamplona

   URBANIZATION PROCESS IN THE SPANISH BASQUE PROVINCES AND ITS CONSEQUENCES

SIXTH CONFERENCE DAY

Thursday, 8 July 1971

V. CONTROL OF NATURAL RESOURCES

8:30 to 12:30 p.m.

1. P. Layhausen, Wuppertal

   THE SCOPE OF HUMAN ECOLOGY

2. D. Colic, Beograd

   THE PROBLEM OF NEGATIVE EFFECTS OF ECOLOGICALLY INADEQUATELY SUPERVISED INTENSIVE LAND CULTIVATION BY THE USE OF SCIENTIFIC METHODS IN AGRICULTURE

3. A. Lah, Ljubljana

   OPEN QUESTIONS AND NECESSARY MEASURES IN CONNECTION WITH TRANSFORMING THE GEOGRAPHICAL ENVIRONMENT AS RESULT OF SOCIAL FACTORS AND SOCIETAL DEVELOPMENT

4. L. Tomanic, Beograd

   SITES ON THE GEOLOGICAL FOUNDATION OF PERIDOTITES AND SERPENTINES IN SERBIA: DEGREE OF DEGRADATION RESEARCH NEEDS AND PROSPECTS FOR THE ELIMINATION OF NEGATIVE HUMAN INFLUENCE

5. Dj. Filipovic, Beograd

   THE EFFECT OF SOIL UTILIZATION ON EROSION AND CROP FARMING YIELDS

6. D. Draskovic, Kraljevo

   THE INFLUENCE OF SOIL EROSION, AGRICULTURAL ALONG THE RIVER MORAVA AND ITS TRIBUTARIES ON THE CONTAMINATION OF THE WATER RESOURCES

VI. PROTECTION OF BIOSPHERE

5 to 7 p.m.

1. S. Mitrovic, Vinca

   METHODS FOR THE ANALYSIS AND EVALUATION OF THE NEGATIVE EFFECTS OF LARGER INDUSTRIES ON THE ENVIRONMENT; METHODS OF FORECASTING

2. M. Nicolau, Bucharest

   AIR POLLUTION CONTROL ON THE WORKING PLATFORMS OF COAL CARBONIZATION PLANTS

3. G. Thirriot, Toulouse

   IS THE STUDY OF RIVER POLLUTION IN THE PRESENT PHASE - A SCIENTIFIC FACT?

4. A. Tuszko, Warsaw

   THE DISTURBANCE OF THE OXYGEN AND BIOLOGICAL BALANCE IN THE AQUATIC ENVIRONMENT AND ITS LOSS OF THE POWER OF SELF-PURIFICATION

5. M. Tadic, Beograd

   DDT AND THE LIVING WORLD

6. M. Saric, M. Fugas, K. Kostial, O. Weber, Zagreb

   THE SIGNIFICANCE OF THE MULTIDISCIPLINARY APPROACH IN THE EXAMINATION OF THE ACTION OF INDIVIDUAL ENVIRONMENT FACTORS OF HEALTH

7. J. C. Lambooy, Amsterdam

   THEORETICAL AND OPERATIONAL PROBLEMS IN TWO ECONOMIC RESEARCH PROJECTS ON ENVIRONMENT

8. R. Feliks, Beograd

   MAXIMUM PERMISSIBLE CONCENTRATIONS OF AIRBORNE, WATERBORNE AND FOOD CONTAINED NOXIOUS MATTER AS INTERCOCCELATED AND AFFECTING THE HEALTH OF HUMANS

9. F. F. Sultanov, B. D. Bagirov, Ashhabad

   THE METODOLOGICAL PRINCIPLES OF THE PHYSIOLOGICAL EVALUATION OF THE INFLUENCE OF NATURAL AND CLIMATIC FACTORS ON MAN IN ARID ZONE

10. R. Misic, Dj. Djurovic, Beograd

THE INFLUENCE OF SOME FACTORS OF THE EXTERNAL ENVIRONMENT ON THE PHYSICAL AND MENTAL HEALTH OF THE INHABITANTS OF THE "STARO SAJMISTE" SETTLEMENT IN BELGRADE

11. P. Dimitrijevic, M. Jovanovic, R. Mancic, R. Rasic, M. Tasic, Leskovac

THE INFLUENCE OF MAN'S ACTIVITY IN THE FORMATION OF HIS ENVIRONMENT AND ITS REFLEXIVE EFFECT ON HEALTH IN LESKOVAC

SEVENTH CONFERENCE DAY

Friday, 9 July 1971

VII. SCIENCE AND EDUCATION

8:30 to 12:30 p.m.

1. D. J. de S. Price, New Haven

SOME THEORETICAL STUDIES IN SCIENCE OF SCIENCE AND THEIR PRACTICAL IMPLICATIONS

2. R. S. Cohen, Boston

SCIENCE AND PEOPLE

3. U. Tomin, Beograd

SCIENCE AS NONENTROPIC FACTOR OF THE SELF-ORGANIZATION OF MAN'S ENVIRONMENT

4. L. Davin, Brussels

THE UNIVERSITY AND SOCIETY OF THE FUTURE

5. E. S. Pierce, Washington

SOCIETY AND SPECIALIST - EDUCATION IN THE ATOMIC AGE

6. Lj. Krneta, Beograd

EDUCATION AS A CONDITION OF DEVELOPMENT AND A FACTOR OF EXISTENCE OF MODERN MAN

7. R. Liston, Knoxville

THE UNIVERSITY - THE LEAVENING
AN ENGINEER'S VIEWPOINT

8. P. Markovic, M. Ninkovic, Vinca

   A CONSIDERATION OF ELEMENTS OF EDUCATION AND INVESTIGATION AS PREREQUISITES FOR MAN'S EXISTENCE IN THE NATURAL ENVIRONMENT

9. E. Vasseur, Drottningholm

   ENVIRONMENT PROTECTION IN SWEDEN

VIII. INFORMATION, LEGISLATION

5 to 7 p.m.

1. J. D. Halloran, Leicester

   THE MASS MEDIA - PROBLEMS AND POSSIBILITIES

2. J. de Laclemandiere, Paris

   FEEDBACK INFORMATION ENVIRONMENT

3. K. Krauch, Heidelberg

   DIRECT DECISION MAKING BY PEOPLE - CITIZENS TV FEEDBACK SYSTEM FOR LONG-RANGE PLANNING

4. B. Krstic, Beograd

   INTEGRAL LEGISLATION IN THE FIELD OF ENVIRONMENT

5. M. Sahovic, V. Vukasovic, Beograd

   CONTEMPORARY INTERNATIONAL LAW AND SCIENCE, MAN AND HIS ENVIRONMENT

6. S. Popovic, Beograd

   THE LEGAL ASPECTS OF THE PROBLEM OF WATER POLLUTION

7. V. Cok, Beograd

   THE LEGAL PROBLEMS CONCERNING THE PROTECTION OF MAN AND HIS ENVIRONMENT FROM THE HARMFUL EFFECTS OF NUCLEAR ENERGY USED FOR PEACEFUL PURPOSES

EIGHTH CONFERENCE DAY

Saturday, 10 July 1971

9 to 10 a.m.

Spare time for additional communications

Closing of the IV International Conference "Science and Society"

10:30 to 12 p.m.

1. Survey of the work of the IV International Conference "Science and Society"

2. Suggestions for the future Conference themes

3. Conclusions

4. Closing address of the Chairman of the Organizing Committee of the International Conference "Science and Society"